the retail market. However, in making that calculation, the cost of the strategy, in terms of foregone profits is generally ignored.

Because of its assumed position in the interconnection market, the LEC can earn whatever profits from interconnection that the market and the regulator will allow. Suppose it sets a high price for interconnection. If it prices its retail service without taking that interconnection price into account, it would reduce the total profits of the firm. On each unit of retail service sold, the LEC would incur two types of costs: the ordinary incremental costs of providing service and the opportunity cost from not providing interconnection (at the high price) for that unit of service. A profit maximizing firm would not sell additional units in the retail market if it realized higher profits from providing interconnection service to its retail competitors.

The only possible explanation for this apparently unprofitable behavior would be that the firm is investing in the destruction of its rivals through predatory pricing. The LEC foregoes profits in the current period in order to drive its competitors from the retail market, raises prices in a later period, and recoups its foregone profits. To succeed, such a strategy requires barriers to entry in the retail market to prevent competitors from re-entering the market during the recoupment period. Since radio licenses are always available to non-LEC competitors and customers incur few costs from switching between suppliers, such a strategy cannot be profitable.[26]

Simultaneous participation in retail and monopoly wholesale markets does create the theoretical possibility of anticompetitive behavior. However, there is generally no economic incentive to actually engage in such conduct. By way of illustration, we examine below the actual history of competitive behavior by LECs in the paging and cellular markets.

---

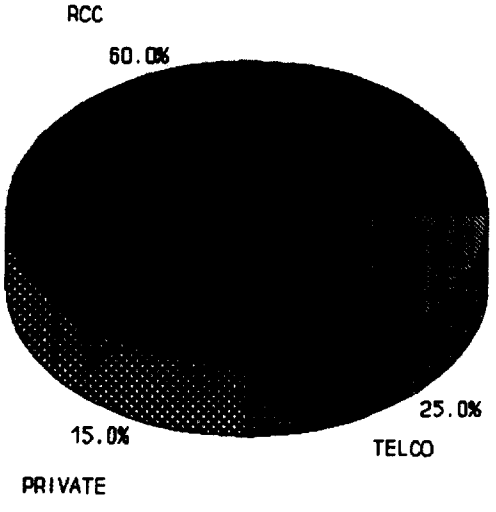
[26]The presence of resellers in the cellular markets makes switching between the Block A and Block B carrier relatively easy. Indeed, the customer may never know the identity of the actual provider of cellular facilities.

2. History

Wireline participation in mobile markets was considered to be in the public interest because of the technical expertise, financial resources, and national presence of the carriers. Opponents of such participation raised the same concerns as discussed in ¶ 72 of the Notice, but subsequent events have shown these fears to have been misplaced.

We discussed the competitive nature of the cellular markets in Section III.A.1, and a similar story occurred in paging. While telephone companies have been important participants in the paging market, they have always been far from dominant. The largest paging company (Paging Network) is not affiliated with a telephone company, and neither are two of the largest firms in the nationwide paging market (SkyTel and Cue). All told, radio common carriers provide the largest share of paging services with telephone company affiliates serving only about 25 percent of the market. See Figure 4. Like the cellular market, the number of paging subscribers has grown

Figure 4
Market Shares of Paging Providers
1989



rapidly, approximately 20 percent per year. The market is also characterized by entry and success (SkyTel's satellite paging service in 1987) and by exit (MCI's sale of its paging and cellular interests to McCaw in 1986, and the sale of NYNEX paging to Page America in 1990).

Perhaps the best evidence that wireline participation in the cellular market does not foreclose competition comes from the wireline carriers themselves. Telephone companies are permitted to acquire an interest in non-wireline carrier services outside of their territory. Thus in Los Angeles, PacTel competes against the non-wireline carrier which is jointly owned by BellSouth and McCaw. The number of markets in which telephone company cellular affiliates compete with one another is growing rapidly, from about 5 in 1986 to 89 in 1991. Presumably, telephone companies are the most knowledgeable about the real risks from anticompetitive conduct on the part of the wireline cellular carriers. Thus, their enthusiastic acquisition of out-of-region non-wireline franchises is powerful evidence that wireline participation is not a deterrent to competition.

3. Discrimination, Cross-Subsidization, and Non-Structural Safeguards

The relationship between a PCS competitor and a LEC license holder is asymmetric, in that the LEC supplies an essential input to the PCS provider. Suppose the LEC were to charge an interconnection price higher than its own retail PCS price. In this case, retail competitors would be unable to match the LEC's retail price and would presumably be driven from the market. Such anticompetitive behavior would involve discrimination because the LEC would effectively charge its retail business a lower price for interconnection than it charged its competitors. The behavior also involves cross-subsidization because the net revenue to the LEC from its retail service would not cover its retail incremental costs plus the opportunity cost (lost contribution) from not providing interconnection to a competitor. We showed earlier that the LEC would not have an economic incentive to undertake such tactics because they result in lower profits. In the last section, we

showed that there is no evidence that this type of behavior has retarded competition in paging and cellular markets.

In this section, we outline two simple non-structural safeguards (two price floors) which can be used to detect and prevent such anticompetitive behavior. To rule out discrimination, the first price floor would require that the LEC's retail operation and its retail competitors pay the same price for interconnection, less any difference in the cost of supplying that interconnection. This price floor would constrain the LEC's retail price to equal or exceed the sum of three components: (i) the LEC's incremental cost for the non-interconnection component of its retail service, (ii) the price it charges competitors for interconnection, and (iii) the difference in incremental cost in supplying interconnection to itself and to its competitors.

To rule out cross-subsidization, our second price floor would require that the price of the retail service equal or exceed its incremental cost including (as opportunity cost) the contribution (interconnection price less interconnection incremental cost) foregone when the LEC provides the retail service instead of interconnection. This price floor is equivalent to the rule that the retail service be priced so that its contribution equals or exceeds the contribution from interconnection.

It is easily shown that these two price floors are mathematically identical. Thus, so long as the LEC prices its retail service at or above the sum of its retail incremental cost and its foregone contribution from interconnection, these anticompetitive concerns are eliminated. Moreover, as we showed earlier, a profit-seeking firm would not knowingly price below this floor, so that there is little need for enforcement.

Further mathematical manipulation of this price floor shows that it has additional efficiency properties.

1. If the LEC and its competitors all price the retail service as low as possible, the LEC will have the lowest price if and only if it has the lowest incremental cost of providing the service. Thus it is neither advantaged nor disadvantaged in the retail market by its provision of interconnection to its competitors.

2. The floor is cost-based because it sets the difference between the retail and wholesale service prices no lower than the difference between the retail and wholesale incremental costs.

3. It rules out cross subsidization because it insures that the LEC obtains at least as much contribution from its competitive retail services as it does from its non-competitive interconnection service.

B. Horizontal Anticompetitive Effects are Unlikely

While the Notice focuses on cross-subsidization and discrimination from LEC participation in PCS markets, the fact that "over time PCS may become a full fledged competitor to wireline services,"[27] raises the issue of concentration and competition in the market for access to the PSTN. Substitution between PCS and landline service is a much-discussed, tantalizing possibility, offering the hope of cutting the copper umbilical cord so that people can call people instead of places. Despite these hopes, however, we show below that PCS and landline services do not compete in the same product market. Thus supply of both services by the local exchange carrier would have no horizontal anticompetitive effect.

First, landline and current cellular services are certainly in different product markets. Taking usage prices and the cost of the telephone into account, the monthly price of cellular service

---

[27] Notice, ¶ 71.

in 1990 was about $95,[28] compared with an average residential local exchange price, including unlimited local calling, of about $18.[29] Moreover, obtaining access by a cellular phone commits the subscriber to obtaining usage through the cellular company. The price of an average switched interLATA toll call during the day is about $0.20 - $0.25 per minute. The price of cellular usage ranges between $0.30 and $0.50 per minute, so that the price of a toll call through a cellular carrier would be more than twice the price using landline access. Subscriber costs of the new digital cellular systems are expected to be roughly half that of the current analog cellular carriers.[30] If wideband PCS prices converge to about that level, PCS will still be significantly more expensive than landline service.

Second, mobile services will probably not have sufficient capacity to compete in the near term for ubiquitous landline local service. Currently, cellular capacity in each MSA is about 500,000 subscribers which will expand considerably when new digital services are implemented. However, current cellular penetration is only between 3 and 4 percent, while residential landline penetration is about 95 percent. In addition, cellular (and PCS) capacity for access to the network depends on peak use, while landline capacity for access does not, since landline access is supplied through a loop dedicated to a single customer. Landline usage per subscriber is currently about 10 times cellular usage per subscriber. Thus it appears unlikely that current technology and spectrum could support widespread substitution of radio for landline service to provide access to the PSTN in the near future.

---

[28]Rohlfs, Jackson, and Kelly, op. cit., p. 18.

[29]Federal Communications Commission, Monitoring Report, CC Docket 87-339, July 1991, p. 153.

[30]J.R. Wickens, N.J. Parker, and B. Blowstein, "PCNs: What's Out, What's New and What's Around the Corner," Telocator, January 1991, p. 26.

Finally, even if substantial substitution occurs between PCS and wireline services at some point in the future, it does not follow that LECs should be denied the ability to acquire a PCS license. The PSTN should be constructed using the most efficient technology--whatever that may be. Radio-based access to the PSTN may be, in certain circumstances, the technology of choice. And if radio technology continues to improve, there is a chance that mobile telephony might replace landline service more pervasively, at least in supplying low bandwidth access to the PSTN. Ironically, it is in this market that local exchange carriers are currently least subject to competition and, consequently, most pervasively regulated. Thus permitting a LEC to acquire a PCS license might--in the distant future--reduce the number of competitors in the low bandwidth access market by one. However, that reduction should have no harmful effect on economic efficiency because--for the foreseeable future--regulation will control service prices in that market.

C. Gains from Integration are Significant

The history of mobile telecommunications in the U.S. shows a strong relationship between the participation of local exchange carriers and the successful development of the market. Landline participation in cellular and paging markets was perceived as important at the time because the wireline carriers had a wealth of experience, technical expertise, and resources. In the cellular market, it was AT&T (then a wireline carrier) that was the primary developer of the technology, and the wirelines were seen as the key to creating national networks.[31]

Many of the same considerations apply to wideband PCS. The large number of small cell sites and the switching and transport requirements of the backhaul network embed the PCS

---

[31] Report, pp. 63-64.

network in the PSTN to a greater extent than for cellular or paging networks. As a result, one could expect to find large economies of scope between PCS and the PSTN based on shared switching and transport facilities. Evidence that these savings are significant is shown by the interest of non-LEC local networks in the PCS market. For example, (i) Cox Enterprises is testing a CDMA broadband PCS system embedded in its cable television infrastructure;[32] (ii) PCS permits have been issued to other cable providers such as Cablevision Systems Corp., Continental Cablevision, Time Warner, and Comcast; and (iii) the largest cellular provider, McCaw, and the largest cable operator, TCI, announced a joint test of McCaw's cellular system integrated into TCI's coaxial and fiber network.[33] Among the metropolitan area networks, Metropolitan Fiber holds experimental PCS licenses. From this activity, we conclude that (i) there are sufficient cost savings from integrated provision of PCS and local network services that it would be wasteful to exclude the LEC networks from participation, and (ii) if PCS grows and becomes a significant fraction of local traffic, LECs will have to be able to supply PCS on an integrated basis to compete as a local network.

At the same time, the LEC network will be required to supply infrastructure for competitors' PCS networks. It is likely to be the case that supplying interconnection and network services to PCS competitors will require facilities and architectures that differ from those used to provide ordinary wireline services. Thus costs of interconnection to all parties would be substantially reduced if the LEC were permitted to participate in the PCS business itself.

On the network side, radio-based access to the voice network is increasingly the technology of choice in certain circumstances. If the LEC is to fulfill its mandate to provide local exchange service in the most efficient manner, it must have a full complement of radio-based services

---

[32]"Cox Completes Second Segment of PCS-Cable Test," Radio Communications Report, June 29, 1992. On October 8, 1992, the FCC awarded Cox a Pioneer's Preference for its technology.

[33]"Experiment Used to Justify Cable's PCS Advantage," Radio Communications Report, March 9, 1992.

in its technology portfolio. For example, cordless payphones substitute directly for LEC payphone services, and where such substitution is economical, we incur a first-order efficiency loss if the LEC were forbidden to use the more efficient technology.

V. AUCTIONS ARE THE MOST EFFICIENT METHOD OF ASSIGNING SPECTRUM

The ultimate economic goal of spectrum allocation is to facilitate the flow of spectrum towards its highest valued use, a task for which free markets are especially well suited and for which administrative processes are not. Based on recent experience in allocating cellular licenses, administrative allocation is fraught with delay[34] and transactions costs, from which we conclude, paradoxically, that less effort should be devoted to the initial assignment of licenses.

However PCS licenses are initially distributed, they should be freely bought and sold among parties that are financially and technically capable of operating them. The complex process of sorting licenses for different territories across firms in some efficient manner is best left to the aftermarket for licenses to accomplish. The ability and efficiency of the market for licenses to accomplish the intricate task of geographic rationalization is evident from recent experience in both the paging and cellular markets.

In paging, the most rapid area of growth is in regional service. Paging companies have organized expanded local paging areas by joint ventures and partnerships, by affiliations of independent companies, and by acquiring the same paging frequencies in different markets. Technological change has helped the process: pagers have been developed which scan the paging

[34]The cellular license process began with applications for the 30 largest SMSAs in June of 1982. By the end of 1984, systems had been licensed in 32 metropolitan areas, rising to 206 by 1987. The allocation process shifted to a lottery system in 1986 for the last 216 SMSAs and all 428 rural service areas (RSAs). By 1989, at least one license had been granted in every SMSA.

channels or the FM subcarrier frequencies making it possible to organize a wide-area paging network without obtaining exclusive use of a single frequency. The regulatory climate has also been helpful, making additional spectrum available for paging use and relaxing restrictions on existing paging frequencies.[35]

The same process is taking place in the cellular markets. McCaw, for example, has coordinated its acquisitions to create eight major clusters serving about 100 MSAs. At the same time, it has sold dispersed interests in Kentucky, Tennessee, and Alabama. Integration was an important motivation for the LIN acquisition:

> "The need for rationalization and consolidation into logical regional groupings is what underlies our offer for LIN and our agreement to buy Metromedia's New York interests. Combined with our corporate properties, they create the potential for state-of-the-art, integrated systems in the Northeast, Texas and California,"[36]

All other major carriers follow similar strategies. The obvious trend in the markets for cellular licenses is to cluster.

From these trends, it is clear that however licenses are geographically distributed at the outset, they will quickly be rationalized by the license market. In this regard, the trend towards removal of restrictions on resale of paging and cellular licenses is helpful, and the rules for exchanging PCS licenses should be no more restrictive. [37]

---

[35]The number of conventional paging channels has increased from 8 in 1981 to 96 today. Restrictions on use of private paging systems have been relaxed, three paging frequencies have been allocated to nationwide paging use, and FM broadcast stations have been allowed to offer paging services on their subcarrier frequencies.

[36]Craig McCaw, McCaw Cellular Communications, Inc., Cellular Communications: A Vision of the Future 7, October 20, 1989, cited in Report p. 100.

[37]For example, the wireline/nonwireline dichotomy in both paging and cellular licensing has not been imposed on the resale market.

As a distribution mechanism, auctions are the most efficient method of allocating spectrum.[38] In general, the license is sold to the party that values it the most, for under certain circumstances, the price actually paid (or its expectation) is the valuation that the runner-up places on the license.[39] Administrative costs are low because only the winning bidder needs to show that it meets technical or financial requirements.

The second best alternative, a lottery, is efficient only because the aftermarket for licenses will correct the random allocation that the lottery produces. Moreover, based on the experience with the cellular lotteries, administrative costs are likely to be high because of the large number of participants. While admission fees and more complex lottery applications would reduce the size of the participant pool--and thus reduce administrative expenses--costs of complex applications are pure social waste. A lottery would not make it more likely that small firms would receive and operate licenses; assuming efficient resale markets, licenses should flow to the hands of the parties that value them the most, irrespective of size. All a lottery would do to encourage small firm participation is award valuable property to firms or individuals at random. The only compelling advantage a lottery has over an auction is that lotteries are currently permitted under law while auctions are not.

If there is no change in the FCC's authority to conduct auctions, the best alternative distribution mechanism would be a postcard lottery[40] followed by an FCC-sponsored competitive auction. The object would be to minimize the cost and complexity of the lottery, since the only

---

[38]See, e.g., R.P. McAfee and J. McMillan, "Auctions and Bidding," Journal of Economic Literature, Vol. XXV,(June 1987), pp. 699-738. Spectrum auctions appeal not only to economists; they have been endorsed by members of the Commission and by recent U.S. presidents.

[39]At least for a first price sealed bid auction.

[40]A postcard lottery requires the minimal amount of information from participants. See the Notice, ¶ 85.

outcome of importance for efficiency would be the result of the auction. No qualifications would be required of applicants, though parties should be limited to a single entry for an individual or corporate entity. Shortly after the lottery, perhaps allowing time for other market mechanisms to work, the Commission would sponsor an optional auction in which licenses would be sold to the highest bidder. The principal advantage of this lottery/auction is that it is nearly as efficient as an ordinary auction in allocating PCS licenses to appropriate parties. The major disadvantage is that the proceeds--reflecting the enormous valuation people appear to place on spectrum rights--would be randomly distributed across the personal and corporate landscape rather than flowing to the government.

CERTIFICATE OF SERVICE

I, David G. Richards, hereby certify that on November 9, 1992, a copy of the foregoing "PCS Comments" was served by United States Mail, postage prepaid to the parties on the attached list, unless otherwise noted.

David G. Richards

David G. Richards

*Chairman Alfred C. Sikes
Federal Communication Commission
1919 M Street, N.W., Room 814
Washington, D.C. 20554

*Commissioner James H. Quello
Federal Communication Commission
1919 M Street, N.W., Room 802
Washington, D.C. 20554

*Commissioner Sherrie P. Marshall
Federal Communication Commission
1919 M Street, N.W., Room 826
Washington, D.C. 20554

*Commissioner Andrew C. Barrett
Federal Communication Commission
1919 M Street, N.W., Room 844
Washington, D.C. 20554

*Commissioner Ervin S. Duggan
Federal Communication Commission
1919 M Street, N.W., Room 832
Washington, D.C. 20554

*Dr. Thomas P. Stanley
Chief Engineer, OET
Federal Communication Commission
2025 M Street, N.W., Room 7002
Washington, D.C. 20554

*Robert M. Pepper
Chief, Office of Plans and Policy
Federal Communication Commission
1919 M Street, N.W., Room 822
Washington, D.C. 20554

*Hand Delivered

John P. Bankson, Jr.
Joe D. Edge
Hopkins & Sutter
PCN America, Inc.
888 Sixteenth Street, N.W.
Washington, D.C. 20006

Jack T. Taylor
TSS Associates
6116 Brassie Way
Redding, CA 96003

Richard M. Stokes
Atlantic Electric
1199 Black Horse Pike
Pleasantville, NJ 08232

Michael Baly, III
President - American Gas
Association
1515 Wilson Boulevard
Arlington, Virginia

Joseph C. O'Neil
U S West Newvector Group, Inc.
3350 161st Ave., S.E.
Bellevue, WA 98008-1329

Leon T. Knauer
Michael Deuel Sullivan
Wilkinson, Barker, Knauer
& Quinn
U S West Newvector Group, Inc.
1735 New York Avenue, N.W.
Washington, D.C. 20006

Laura D. Ford
Lawrence E. Sarjeant
Randall S. Coleman
U S West Newvector Group, Inc.
1020 19th Street, N.W.
Suite 700
Washington, D.C. 200036

Robert G. Lott
DoveCo Communications
1929 Martindale Drive
Fayetteville, NC 28304

Lawrence J. Movshin
Thelen, Marrin, Johnson &
Bridges
IEEE Standards Project 802
805 15th Street, N.W.
Washington, D.C. 20005-2207

Colonel Socrates G. Lecakes
Deputy Superintendent
New York State Police
Public Security Building
State Campus
Albany, NY 12226

Honorable Thomas J. Bliley, Jr.
House of Representatives
2241 Rayburn House Office Bldg.
Washington, D.C. 20515-4603

Donald J. Helm
Washington Gas
1100 H Street, N.W.
Washington, D.C. 20080

Paul R. Kessler
New York Eye and Ear Infirmary
2nd Avenue at 14th Street
New York, NY 10003

Mark K. Roberts
Superintendent of Communications
SCADA, and Metering
Grand River Dam Authority
P.O. Box 409
Vinita, OK 74301-0409

George W. Toyne
General Manager
Corn Belt Power Cooperative
1300 Thirteenth St.
P.O. Box 508
Humboldt, Iowa 50548

Ronald C. Oakley
Manager - Telecommunications
Arkansas Power & Light Co.
425 West Capitol
Little Rock, AR 72203

James A. Vann, Jr.
Executive VP and General Manager
Alabama Electric Cooperative, Inc.
P.O. Box 550
Andulusia, AL 36420

John K. Davis
General Manager
Sho-Me Power Corporation
Marshfield, MO 65706

Michael P. Sercer
Communications Supervisor
Indianapolis Power & Light Co.
P.O. Box 1595
Indianapolis, IN 46206

Steve Slaughter
Engineering Manager
Guadalupe Valley Electric
Cooperative, Inc.
P.O. Box 118
Gonzales, TX 78629-0118

Richard McKenna HQE03J36
GTE Service Corporation
P.O. Box 152092
Irving, TX 75015-2092

W. Lester Bryan
VP - Power Supply
Washington Water Power
P.O. Box 3727
Spokane, WA 99220

Jackson H. Randolph
President & Chief Executive Officer
Cincinnati Gas & Electric Co.
P.O. Box 960
Cincinnati, Ohio 45201-0960

Glen D. Churchill
President & Chief Executive Officer
West Texas Utilities Co.
P.O. Box 841
Abilene, TX 79604

Harry D. Mattison
Executive Vice President &
Chief Operating Officer
Central and South West Corp.
P.O. Box 660164
Dallas, TX 75266-0164

Joseph W. Koch, Jr.
Manager
The Gas Company
P.O. Box 3249
Los Angeles, CA 90051-1249

Dennis L. Hill
Data Retrieval Manager
Northwest Iowa Power Cooperative
P.O. Box 240
Le Mars, Iowa 512031

Miles Walters
SC/DA Engineer
Dept. of Public Utilities
County of Los Alamos
P.O. Box 30
Los Alamos, NM 87544

Gene H. Kuhn
Director Telecommunications
Transmission
Union Pacific Railroad Co.
Missouri Pacific Railroad Co.
1416 Dodge St.
Omaha, NE 68179

Ted V. Lennick
General Manager
Cooperative Power Association
14615 Lone Oak Road
Eden Prairie, MN 55344-2287

Mary M. Polfer
Vice President
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, OK 74102-0201

John A. Bohling
Executive Vice President
Pacific Power & Light Co.
920 S.W. Sixth Avenue
Portland, OR 97204

Ruben Morgan
Supervisor Relay & Communications
Electric T & D Division
City of Tallahassee
2602 Jackson Bluff Road
Tallahassee, FL 32304

Dale V. Fetchenhier
VP - Information and Technology & Service
Public Service Company of Colorado
P.O. Box 840
Denver, CO 80201-0840

Tom Moore
Director, System Operations
Western Farmers Electric Cooperative
P.O. Box 429
Anadarko, OK 73005

Melvyn Cobb
Manager, System Communications
Kentucky Utilities Company
One Quality Street
Lexington, KY 40507

Kevin M. Walsh, P.E.
Manager, Network Engineering and Maintenance
Niagara Mohawk Power Corp.
300 Erie Boulevard West
Syracuse, NY 13202

Arthur K. Neill
Executive Vice President
Montana Power Company
40 East Broadway
Butte, MT 59701

Robert R. Carey
President and Chief Executive Officer
Central Power and Light Company
P.O. Box 2121
Corpus Christi, TX 78403

John W. Paylor
Director of Information Services
Southwestern Electric Power Co.
P.O. Box 21106
Shreveport, LA 71156-0001

Wayne C. Hamilton
Manager, Telecommunications Dept.
Carolina Power & Light Company
P.O. Box 1551
Raleigh, NC 27602

John L. Sokol, Jr., P.E.
Executive Director
Pennsylvania Turnpike
Commission
Harrisburg, PA 171105

John L. Rafuse
Manager, Government Relations
Unocal
P.O. Box 7600
Los Angeles, CA 90051

David L. Rountree
Director of Engineering
Northeast Oklahoma Electric
P.O. Box 948
Vinita, OK 74301-0948

David B. Trego
Manager, Telecommunications
Division
American Electric Power
Service Corporation
1 Riverside Plaza
Columbus, OH 43215

Warren K. Lotsberg
Vice President - Consumer Affairs
Northwestern Public Service Co.
P.O. Box 1318
Huron, SD 57350-1318

Bruce B. Samson
Northwest Natural Gas Co.
One Pacific Square
220 N.W. Second Avenue
Portland, OR 97209

William A. Merrill
Vice President - Operations
Nebraska Public Power District
P.O. Box 499
Columbus. NE 68602-0499

John C. Anderson
Executive Vice President
Southside Electric Cooperative
P.O. Box 7
Crewe, VA 23930

Ralph E. Shaw
General Manager
Northeast Missouri Electric
Power Cooperative
P.O. Box 191
Palmyra, MO 63461

Douglas W. Johnson
Executive Vice President
Blue Ridge Electric
Membership Corporation
Caller Service 112
Lenoir, NC 28645

Byron R. Bergman
Asst. Systems Engineering Manager
Light Division
Tacoma Public Utilities
P.O. Box 11007
Tacoma, WA 98411

Louis Stroup. Jr.
Executive Director
Kansas Municipal Utilities, Inc.
P.O. Box 1225
McPherson, KS 67460

Jerome J. Mistek
Manager, Communications and
Metering
Interstate Power Company
P.O. Box 769
Dubuque, Iowa 52004-0769

Chandos A. Rypinski
LACE, Incorporated
921 Transport Way
Petaluma, CA 94954

Tom W. Davidson
Mark D. Schneider
Clairtel Communications
Sidley & Austin
1722 Eye Street, N.W.
Washington, D.C. 20554

Daniel L. Bart
1850 M Street, NW
Suite 1200
Washington, DC 20036

Stuart Dolgin
Local Area Telecommunications
17 Battery Place, Suite 1200
New York, NY 10004-1256

Werner K. Hartenberger
Laura H. Phillips
Down, Lohnes & Albertson
1255 23rd Street, NW
Suite 500
Washington, DC 20037

John D. Lane
Wilkes, Artis, Hedrick & Lane
1666 K Street, NW
Suite 1100
Washington, DC 20006-2866

Leonard Robert Raish
Fletcher, Heald & Hildreth
1225 Connecticut Avenue, NW
Suite 400
Washington, DC 20036-2679

Craig O. McCaw
Mark R. Hamilton
McCaw Cellular Communications, Inc.
5400 Carillon Point
Kirkland, WA 98033

Stephan P. Carrier
Hughes Network Systems, Inc.
11717 Exploration Lane
Germantown, MD 20874

John C. Carrington
Mercury Personal Communications Network, Ltd.
1 Harbour Exchange Square
London E14 9GE, UK

David A. LaFuria
Lukas, McGowan, Nace & Gutierrez
1819 H Street, NW
Seventh Floor
Washington, DC 20006

Marilyn M. Moore
Michigan Public Service Commission
6545 Mercantile Way
P.O. Box 30221
Lansing, MI 48909

John E. Hoover
Jones, Day, Reavis & Pogue
1450 G Street, NW
Washington, DC 20005-2088

Tak Immamura
Mitsubishi Electric Corporation
1-1, Tsukaguchi - Honmachi
8-Chome
Amagasaki City, Hyogo 661, Japan

Stuart E. Overby
Michael D. Kennedy
Leonard S. Kolsky
Motorola Inc.
1350 I Street, NW
Suite 400
Washington, DC 20005

David E. Weisman
Myer, Faller, Weisman & Rosenberg
4400 Jenifer Street, NW
Suite 380
Washington, DC 20015

David F. Evans
MCI Communications Corporation
1801 Pennsylvania Ave., N.W.
Washington, DC 20006

William H. Talmage
NCR Corporation
1700 S. Patterson Blvd.
Dayton, OH 45479

Dr. Robert L. Riemer
Committee on Radio Frequencies
National Research Council
2101 Constitution Ave.
Washington, DC 20418

Penny Rubin
New York State Department of
Public Service
Three Empire State Plaza
Albany, NY 12223

James G. Ennis
Fletcher, Heald & Hildreth
1225 Connecticut Ave., NW
Suite 400
Washington, DC 20036

Northern Telecom, Inc.
Albert Halprin
Werner, Lipfert, Bernnard,
McPherson and Hand
901 15th Street, NW
Washington, DC 20005

Charles T. Force
National Aeronautics and Space
Administration
Washington, DC 20546

Roland Williams
NovAtel Communications, Ltd.
1020 - 64 Avenue, NE
Calgary, Alberta, Canada
T2E 7V8

Michael C. Rau
National Association of
Broadcasters
1771 N Street, NW
Washington, DC 20036

Dennis L. Hill
Northwest Iowa Power Cooperative
P.O. Box 240
Le Mars, Iowa 51031

Joseph P. Markoski
Squire, Sanders & Dempsey
1201 Pennsylvania Avenue, N.W.
P.O. Box 407
Washington, DC 20044

Raymond A. Kowalski
Blooston, Mordkofsky, Jackson
& Dickens
2120 L Street, NW
Washington, DC 20037

David Cosson
National Telephone Cooperative
Association
2626 Pennsylvania Ave., NW
Washington, DC 20037

Ericsson Corporation
David C. Jatlow
Young & Jatlow
2300 N Street, NW
Suite 600
Washington, DC 20037

David A. Hendon
Department of Trade and
Industry
Kingsgate House
56-74 Victoria Street
London SW1E 6SW England

Scott J. Loftesness
Fidelity Investments
82 Devonshire Street
Boston, MA 02019

Leonard Robert Raish
Fletcher, Heald & Hildreth
1225 Connecticut Avenue, NW
Washington, DC 20036-2679

Lawrence R. Krevor
Jones, Day, Reavis & Pogue
1450 G Street, NW
Washington, DC 20005

Jack T. Taylor
Digital Spread Spectrum
Technologies, Inc.
110 South Wolfe Road
Sunnyvale, CA 94086

William L. Fishman
Sullivan & Worcester
1025 Connecticut Avenue, NW
Washington, DC 20036

James A. Dwyer, Jr.
2100 Electronics Lane
Fort Myers, FL 33912

Andrew D. Lipman
Swidler & Berlin
3000 K Street, NW
Washington, DC 20007

George J. Brennan
NYNEX Corporation
120 Bloomingdale Road
White Plains, NY 10605

Veronica M. Ahern
Nixon, Hargrave, Devans & Doyle
One Thomas Circle
Suite 800
Washington, DC 20005

Lisa M. Zaina
OPASTCO
2000 K Street
Suite 205
Washington, DC 20005

Peter Tannenwald
Arent, Fox, Kintner, Plotkin & Kahn
1050 Connecticut Ave., NW
Washington, DC 20036-5539

Nancy J. Thompson
Reed, Smith Shaw & McClay
1200 18th Street, NW
Washington, DC 20036

Paul R. Zielinski
Rochester Telephone Corp.
180 South Clinton Avenue
Rochester, NY 14646-0700

G. Todd Hardy
PCN America, Inc.
153 East 53rd
New York, NY 10022

John W. Hunter
McNair Law Firm, P.A.
1155 Fifteenth Street, NW
Washington, DC 20005

Michael S. Slomin
Bell Communications Research, Inc.
290 W. Mt. Pleasant Avenue
Livingston, NJ 07039

Elizabeth F. Maxfield
Michael F. Altschul
Cellular Telecommunications
Industry Association
1133 21st Street, NW
Suite 300
Washington, DC 20036

Paul R. Rodriquez
Leventhal, Senter & Lerman
2000 K Street, NW
Suite 600
Washington, DC 20006-1809

James E. Taylor
Frost & Jacobs
2500 Central Trust Center
201 East Fifth Street
Cincinnati, OH 45202

Lynn Diebold
California Public Safety Radio
Association
4016 Rosewood Avenue
Los Angeles, CA 90004

William J. Cole
Cobra Electronics Group of
Dynascan Corporation
6500 West Cortland Street
Chicago, IL 60635

Kenneth J. Brown
Capital Cities/ABC, Inc.
77 West 66th Street
New York, NY 10023

Linda T. Muir
Contel Corporation
245 Perimeter Center Pkwy.
Atlanta, GA 30346

F.G. Harrison
Cellnet
Hanover House
49-60 Borough Road
London SE1 1DS
England

Ted V. Lennick
Cooperative Power
14615 Lone Creek Road
Eden Prairie, MN 55344-2287